

Abstract submitted to:

American Geophysical Union, Fall Meeting 2012
San Francisco, California, 3 – 7 December 2012
<http://fallmeeting.agu.org/2012/>
SM021 Space Weather Effects on Spacecraft,
Aircraft, and Ground Systems

Extreme Spacecraft Charging in Polar Low Earth Orbit

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Spacecraft in low altitude, high inclination (including sun-synchronous) orbits are widely used for remote sensing of the Earth's land surface and oceans, monitoring weather and climate, communications, scientific studies of the upper atmosphere and ionosphere, and a variety of other scientific, commercial, and military applications. These systems episodically charge to frame potentials in the kilovolt range when exposed to space weather environments characterized by a high flux of energetic (~10's kilovolt) electrons in regions of low background plasma density which is similar in some ways to the space weather conditions in geostationary orbit responsible for spacecraft charging to kilovolt levels. We first review the physics of space environment interactions with spacecraft materials that control auroral charging rates and the anticipated maximum potentials that should be observed on spacecraft surfaces during disturbed space weather conditions. We then describe how the theoretical values compare to the observational history of extreme charging in auroral environments. Finally, a set of extreme DMSP charging events are described varying in maximum negative frame potential from ~0.6 kV to ~2 kV, focusing on the characteristics of the charging events that are of importance both to the space system designer and to spacecraft operators. The goal of the presentation is to bridge the gap between scientific studies of auroral charging and the need for engineering teams to understand how space weather impacts both spacecraft design and operations for vehicles on orbital trajectories that traverse auroral charging environments.